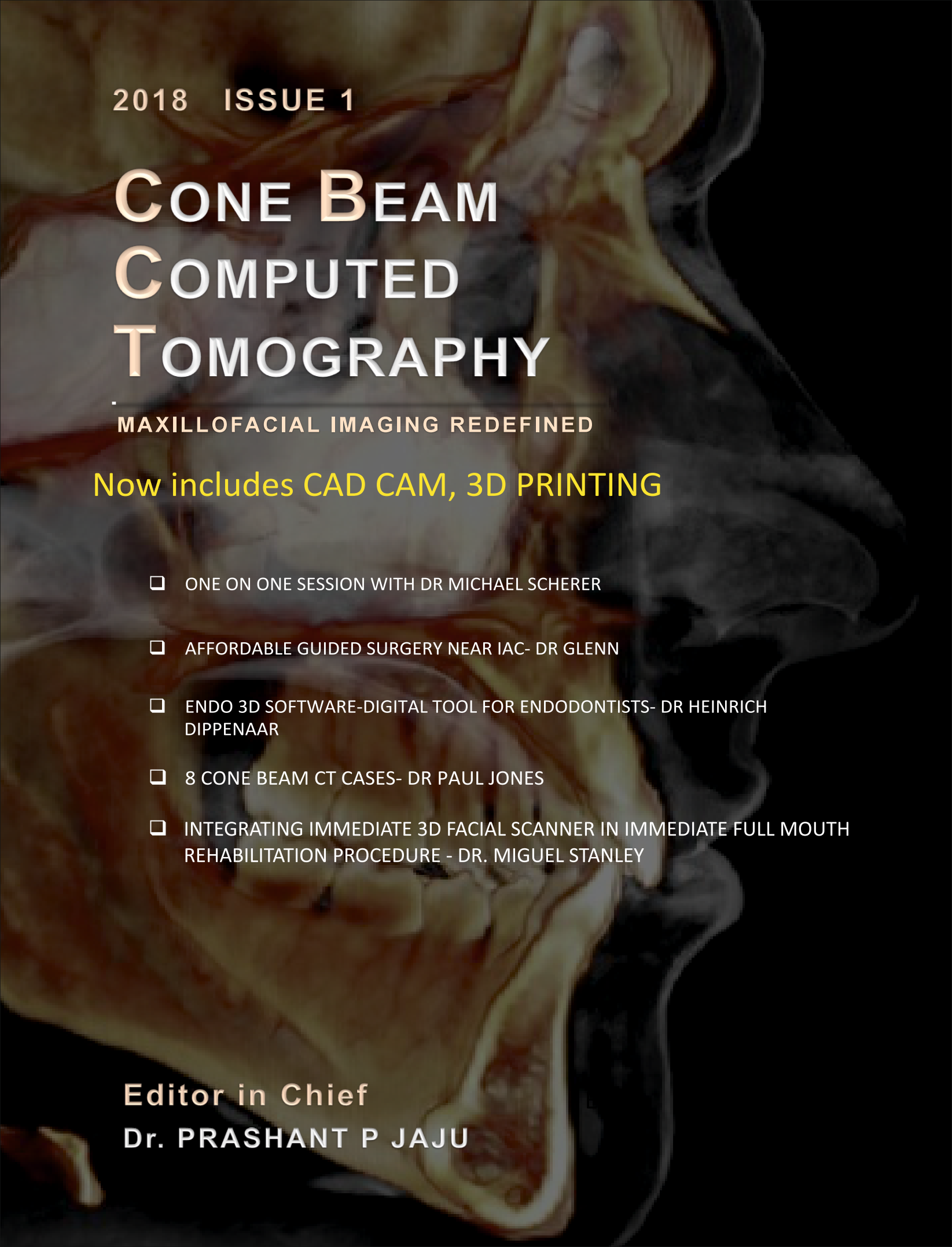

2018 ISSUE 1

CONE BEAM COMPUTED TOMOGRAPHY

MAXILLOFACIAL IMAGING REDEFINED

Now includes CAD CAM, 3D PRINTING

- ONE ON ONE SESSION WITH DR MICHAEL SCHERER
- AFFORDABLE GUIDED SURGERY NEAR IAC- DR GLENN
- ENDO 3D SOFTWARE-DIGITAL TOOL FOR ENDODONTISTS- DR HEINRICH DIPPENAAR
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Editor in Chief
Dr. PRASHANT P JAJU

CBCT
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2018

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FROM THE EDITOR'S DESK

Dr. Prashant P. Jaju BDS, MDS (Oral Medicine & Radiology)

Hello Readers,

As we approach towards the end of the year , we present the next issue of our magazine.

Our Latest issue is going to be one of the best issues we had so far, with case reports and articles from the best clinicians of across the globe.

There are host of cases ranging from surgical guided surgery to anatomical variations and endodontics management via CBCT.

We also have a very special One-on-One session with Dr. Michael D. Scherer, who is the mind behind the Blue Sky Bio Software and one of the greats in guided surgery and 3D printing. I also take this opportunity to thank my entire editorial board members who have spared their valuable time for making this issue happen. Personally I wish to thank my co editors, Dr. Sushma Jaju and Dr. Arpan Shrivastav for designing and arranging such wonderful articles.

Our international collaborators, Ms. Kristy Montoya and Dr. Sana who are responsible for interviewing, gathering articles, editing materials, and sharing our magazine across the globe to the dental fraternity.

Our review team members who have been meticulous in reading each article and suggesting necessary corrections required.

I also wish to thank my commercial partners , Dentsply Sirona India , Carestream India, Diya Dental Imaging for extending their support all year for our magazine.

We wish to inform you that , from 2018 our magazine would be an e-journal which will be available online for free at our website at www.oralimagingsolutions.com

AFFORDABLE GUIDED SURGERY NEAR THE INFERIOR ALVEOLAR NERVE

Dr. Glenn

Dr. Glenn

Dr. Glenn graduated from University of Tennessee Health Science Center College of Dentistry. Following graduation, he went on to complete the Lutheran Medical Center's advanced education in general dentistry residency at the UT Memphis branch. He is a graduate of the Georgia Maxi Course in Implant Dentistry, the American Orthodontic Society's Comprehensive Ortho Program, and is credentialed as an Associate Fellow in the American Academy of Implant Dentistry. He has served as the CE director for the TN AGD and as president and CE director of the Middle TN Dental Study Club. Dr. Glenn is also one of the founders of the online learning center, Blue Sky Bio Academy. For several years, Dr. Glenn ran a private practice in Winchester, TN where he performed all disciplines of dentistry with a particular focus on utilizing technology and innovative techniques to provide treatment in an efficient and cost-effective manner while still maintaining the highest level of quality. However, in 2016, he was diagnosed with APL leukemia and spent 8 months doing chemotherapy. He is now in complete remission but due to back issues following treatment, he has since retired from clinical practice and now focuses entirely on dental technology and teaching. He is now the VP of Technology for Blue Sky Bio where he works in product and software development as well as clinical customer support. He speaks extensively on the topics of CAD/CAM, cone beam technology, and guided dental implants, dental photography, digital smile design, complete dentures, and complex full mouth rehabilitation.

Introduction:

CBCT guided surgery provides clinicians many benefits compared to free handed surgery including more accurate surgical placement of dental implants, faster surgeries, the ability to more easily avoid vital structures, and being able to pre-make prosthesis in advance of surgery. Despite the many benefits, there are still significant barriers that have prevented many dentists from embracing the process. In my experience of teaching guided surgery to thousands of dentists, I can say these barriers usually come down to 2 factors: cost and complexity. The aim of this article is to show how the free Blue Sky Plan software and the Direct Cut Drill approach removes both of these barriers and allows clinicians to efficiently and affordably generate CBCT guided surgical stents.

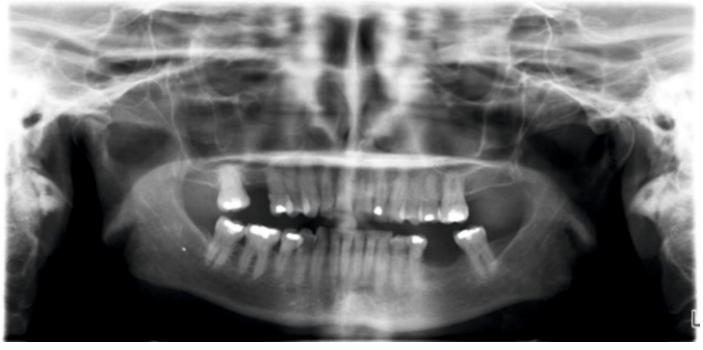
It has historically been very expensive to create a CBCT guided surgical stent for a few reasons. First, the need for a CBCT scan of the patient is a requirement for guided surgery. While the price of CBCT machines has come down in recent years, many clinicians still have difficulty justifying the return on investment from such a large purchase. Thankfully, it is not necessary for the clinician to own a machine but, rather, they just need to be able to refer the patient to the appropriate colleague or imaging center for the scan. Any CBCT scanner will work for this purpose and the images should just be saved in the raw DICOM format rather than with any embedded viewing software.

In addition, most guided surgery software is very expensive to purchase initially and even then, requires ongoing support fees and pay-per-use fees. They also have a steep learning curve if you are not computer savvy. As a result, it has historically been necessary for the dentist to send the scan data and models of the patient to a lab that owns the software so that they could do the planning and generate the stent. By contrast, Blue Sky Plan is entirely free to download and use and completely open source in that it can be used with any type of implant or kit. There are built in self-teaching modules in the software and many free

training videos online. Once you are familiar with the software, it should routinely take only 5-10 minutes to complete all the planning. There is also a tremendous amount of value in the clinician doing the planning themselves since they will have a much more intimate knowledge of the case and the patient's anatomy. The only cost involved is a small export fee of less than $20 per case. Once exported, the clinician has the STL file of the guide and they can 3d print or mill it.

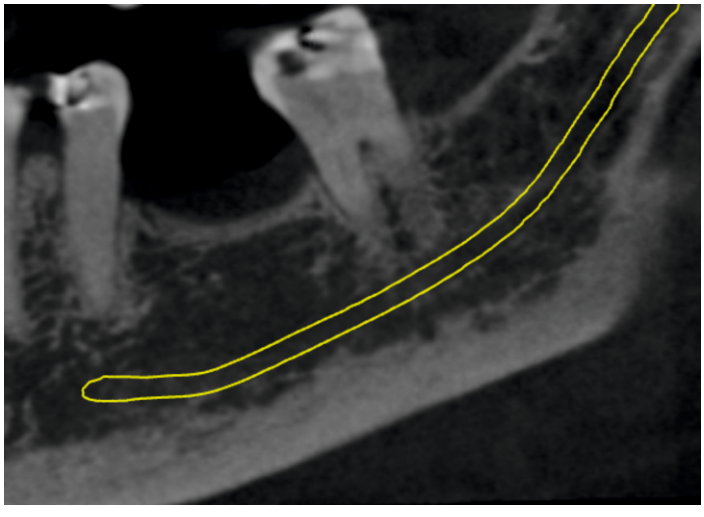
Once the planning and guide fabrication are complete, it is time to proceed with the surgery using an appropriate guided kit. However, this presents an additional problem in that most guided surgical kits are extremely expensive and they are proprietary to a particular brand of implant. One alternative solution is to utilize the Direct Cut Drills from Blue Sky Bio. These efficient cutting drills are parallel walled and are paired with specifically matched surgical guide tubes which enable the surgeon to utilize a single drill approach. Rather than proceeding up through several sequential drills, a single final diameter drill is used with a pumping motion to advance 1-2 mm at a time until full depth is reached. The guide controls both the trajectory and the depth of the osteotomy. It also drastically reduces the surgical armamentarium from an entire kit down to a few drills thus, reducing the cost as well. The drills are available in a wide array of sizes accommodating implants ranging from 3.0 up to 5.0. This means that the technique can be adapted to place any brand of implant by just choosing the correct final diameter drill for whatever type implant you desire to place.

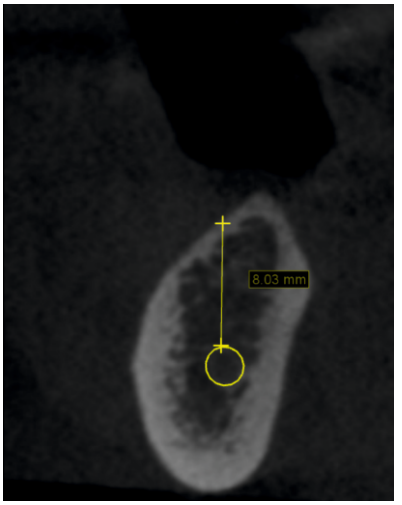
The following case demonstrates the simplicity and accuracy of the technique for a case where the implant needs to be placed in close proximity to the inferior alveolar nerve. The patient was a 64 year old female who had been missing #19 for many years. The panoramic radiograph showed vertical atrophy in the edentulous site and the location of the inferior alveolar canal was inconclusive based on the 2d images alone.



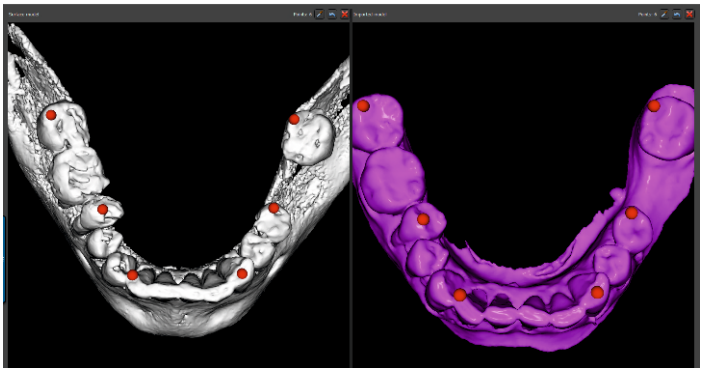
A CBCT was taken of the patient as well as a study model which will need to be digitized. It is necessary to have a digital STL model of the patients arch and there are many ways to generate that. An optical scan can be taken with a desktop scanner or, a cbct scan can be taken of the cast or impression to generate the STL. The CBCT data and the STL model are all that is needed to generate a surgical guide.

The CBCT data was first opened in Blue Sky Plan and the inferior alveolar canal is mapped revealing 8 mm of bone height before encountering the nerve.

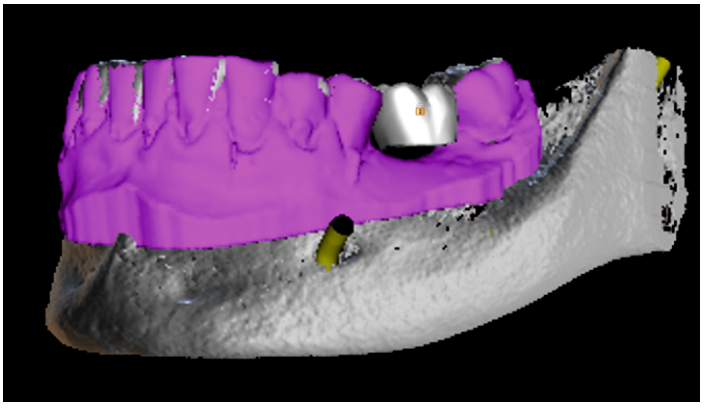


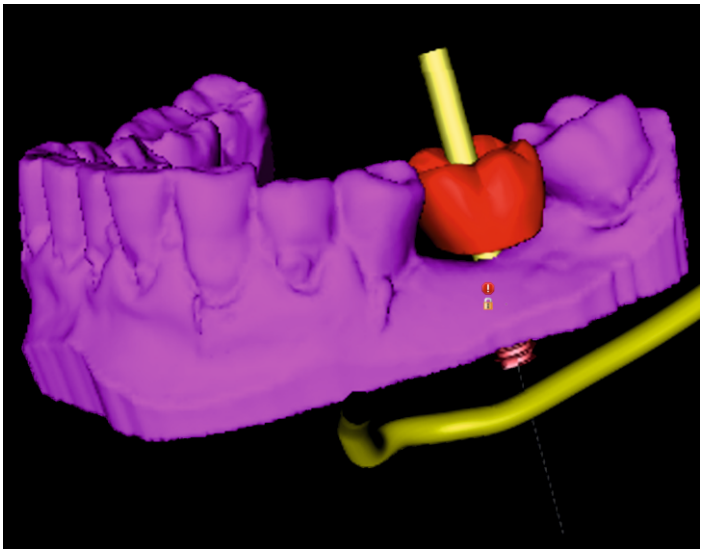


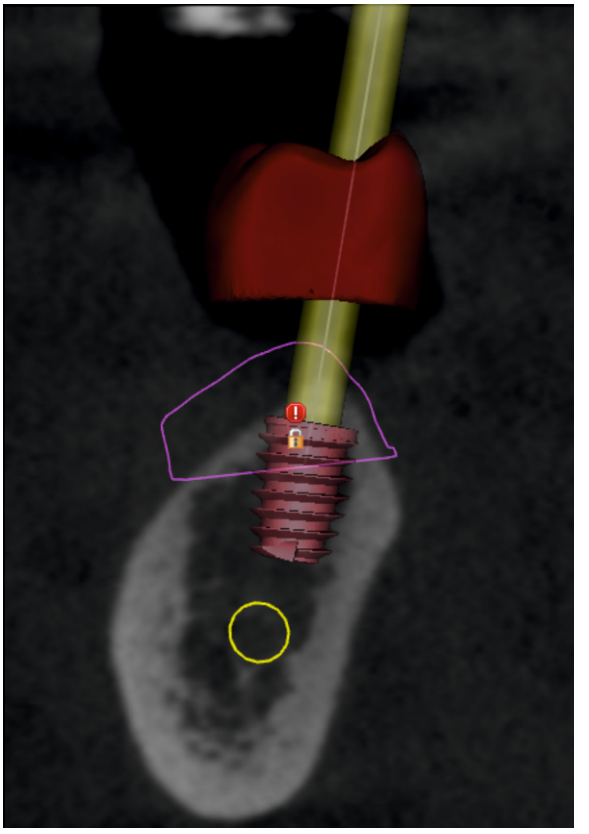
Then, the STL model was merged by selecting common data points between the CBCT rendering and the model.



Because an STL model does not suffer from the scatter and distortion that a cone beam rendering does, it allows much better visualization for planning the restorative endpoint. Prosthetic teeth from the Blue Sky Plan library can be positioned and a virtual implant can be positioned for the best compromise between surgical and prosthetic positions. In this case, a short Blue Sky Bio Max, 4.3 x 6.0 mm implant was chosen to leave a 2mm zone of safety between the implant and nerve.

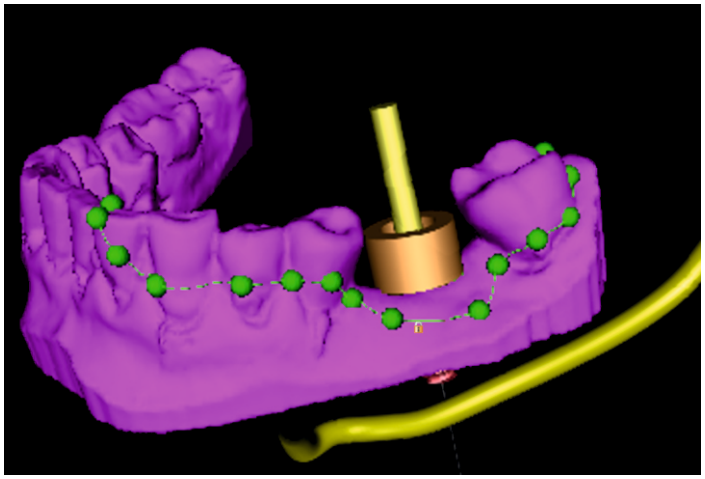


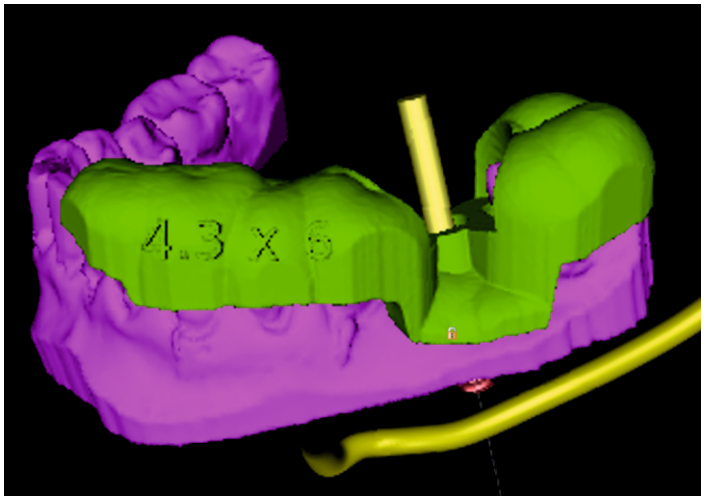




The surgical guide was created by turning on the guide tube and drawing the desired perimeter. Once

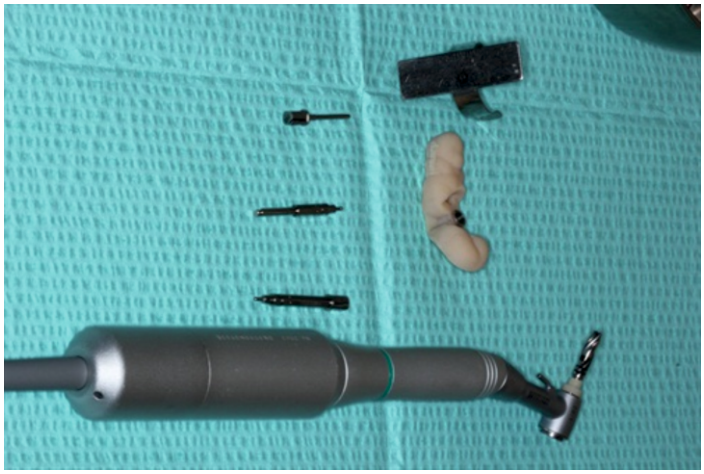
the software fabricated it, the guide was exported to be 3d printed.



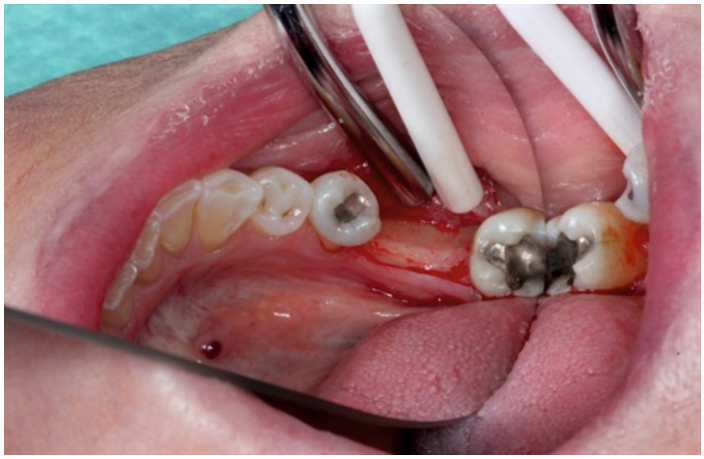


In preparation for the surgery, the metal guide sleeve was placed into the printed guide and the fit was verified on the model.

Since only a single drill was needed for creating the osteotomy, a minimal surgical armamentarium was needed to carry out the procedure.

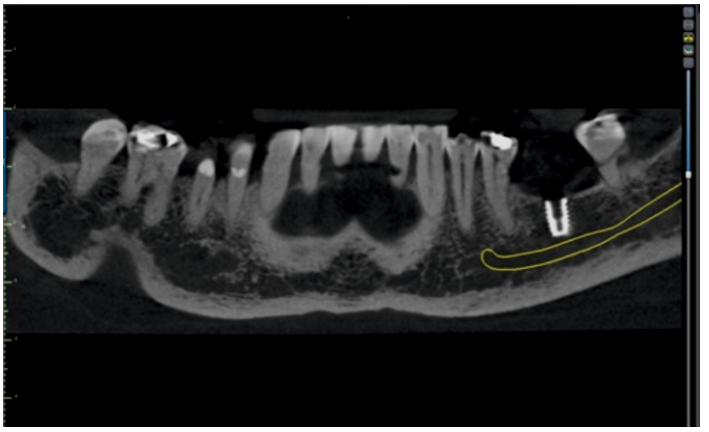


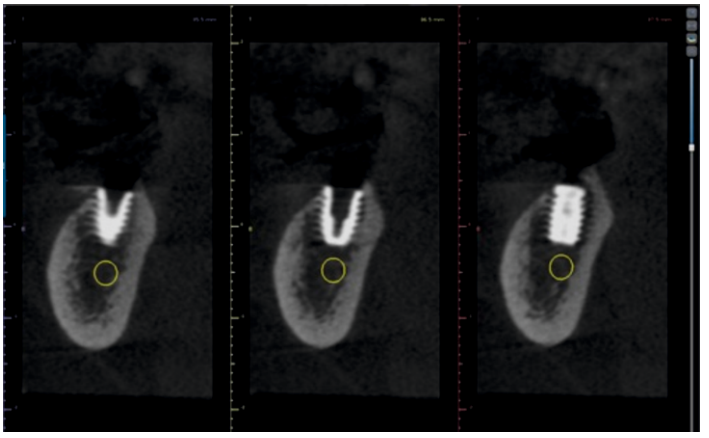
A small crestal incision was made to expose the crestal bone and the surgical guide was placed in the mouth. The Direct Cut Drill was used at 1200 rpms with copious irrigation to gradually proceed to full depth. The drill stop prevented the drill from going beyond the intended length and damaging the nerve.

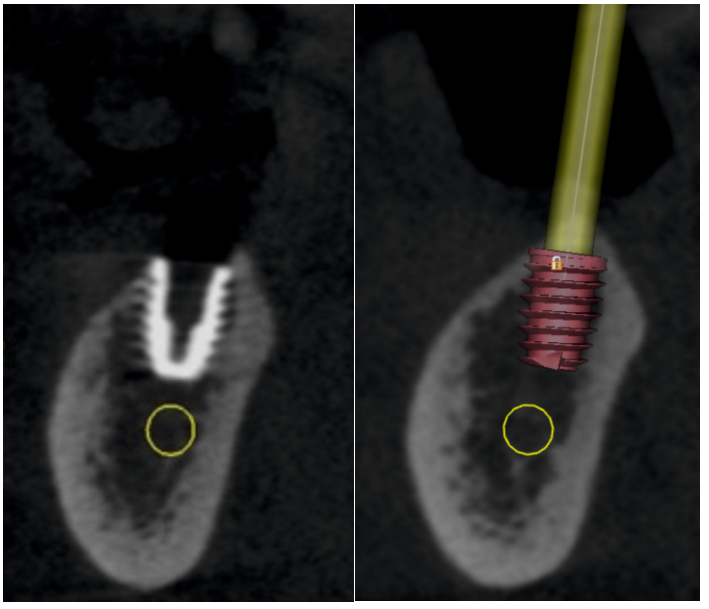


Upon completion of the osteotomy, the implant was

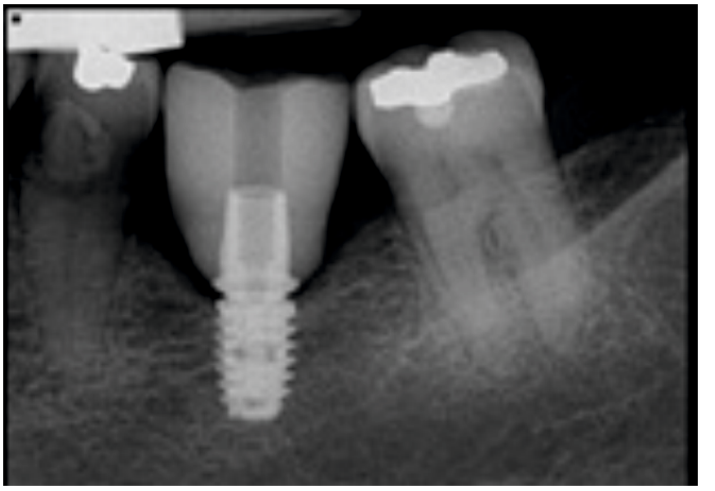
placed to depth with excellent primary stability and a cover screw was placed. Full primary closure was achieved and, due to the nerve proximity, a post-operative CBCT was completed to verify the positioning. The placement exactly mirrored the planned implant position.







After 3 months of integration, the implant was uncovered and restored with a CADCAM screw retained crown.



In this case, I was able to place accurately place this implant exactly according to the digital treatment planning that I'd completed while maintaining an appropriate zone of safety away from the inferior alveolar nerve. Guided surgery is a valuable tool for clinicians to utilize. Blue Sky Plan has changed the paradigm enabling doctors to perform this procedure accurately and at a minimal cost.

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ENDO 3D SOFTWARE - DIGITAL TOOL FOR ENDODONTISTS

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Dr. Heinrich Dippenaar

Certified Dentsply Maillefer Trainer 2009 Switzerland. CBCT and 3D Endo software training 2017 Bensheim Germany |

Part time Lecturer at University of Pretoria Post Graduate Endodontic Diploma

Over the last ten years the use of CBCT in endodontic treatment has gained huge popularity. Soon the dentists would realize that CBCT is not just for implant planning and surgical assessments but can also play a vital role in endodontic procedures. One can only treat what one can see and diagnose, but now with the 5 x 5 limited field scanning which is the option in most of the CBCT machines, CBCT 3D imaging has became the integral part in the standard endodontic treatment protocols.

It saves a lot of time since you can access the number of canals present in the tooth which require treatment before the treatment commences.

Dentsply-Sirona has taken the Endodontic world by storm with the launch of their new 3D Endo Software which is specifically designed and developed for pre endodontic planning.

The software helps you to design a conservative access cavity which enables you to find all the canals and preserves the tooth structure. With this software it is also, now possible to calculate the number of canals and the length of each along with the endodontic instrument which can optimally clean and shape them without removing much of tooth structure.

A 53 year old patient presented with irreversible pulpitis with 46 at my center. On a peri-apical radiograph an extra distal root was evident.

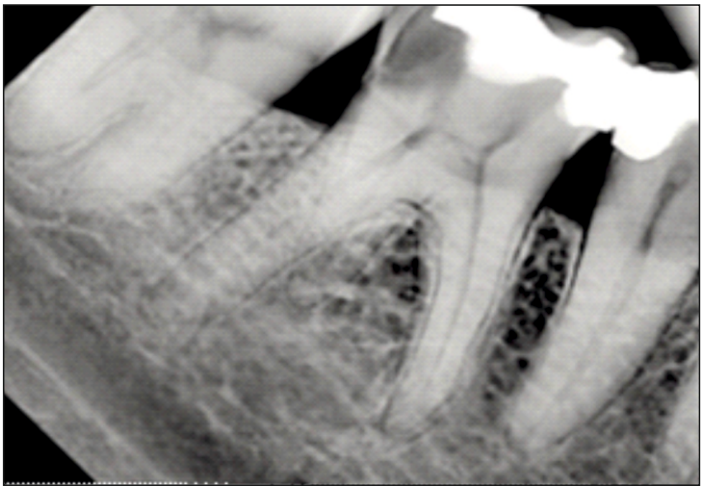

Fig 1. Pre-op 2D x-ray showed indication of extra distal root

Fig 2. I took a 5 X5 limited FOV CBCT with my ORTHOPHOS SL and discovered an extra root on 46.This is called Radix entomolaris (Radix paramolaris when extra root is located buccal).The scan was imported to the 3D ENDO software and preplanning was done.

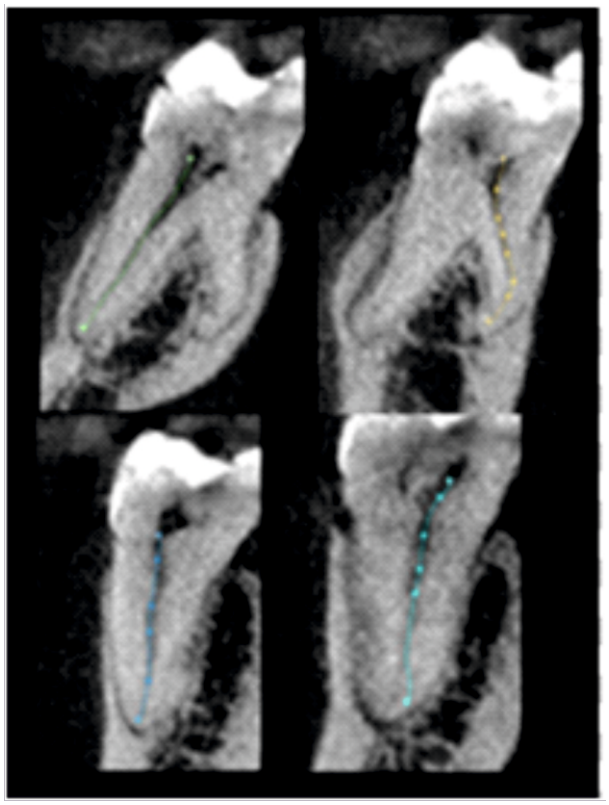

Fig 3. Coronal 5x5 CBCT with extra distal root clearly visible

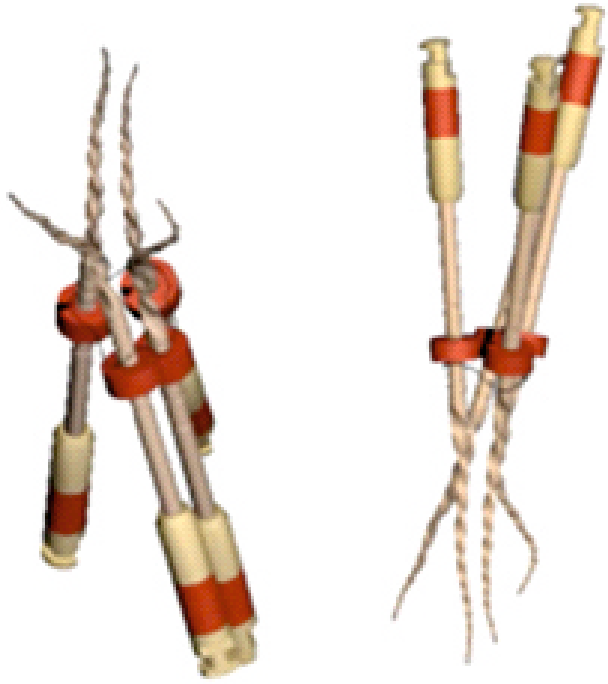

Fig 5.Different angles with 3D ENDO software with planned WaveOne Gold PRIMARY (RED 25 TIP SIZE) for each canal. On turning the simulation one realizes what tortional stress endodontic files endure during treatment.

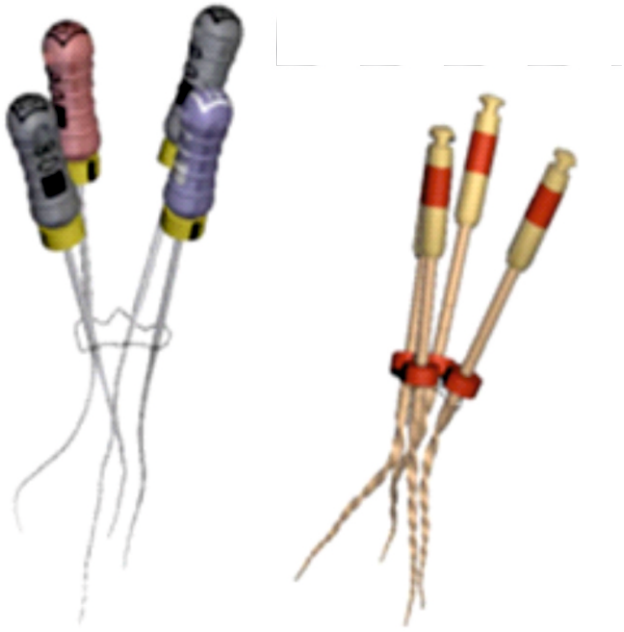

Fig 4. Canal plotting in 3D ENDO software -Look at the severe curve of the extra distal root and length determination in software. All the canals are separate and don't merge at the apices

Fig 6a. four canal orifices visible, 6b and 6c length determination with help of apex locator

Fig 7. Post-op x-ray. All four canals obturated with WaveOne Gold primary files

If I look at the post op x-ray I can't help but comment about the conservative canal preparation done with the WaveOne Gold Files. The new gold metal is very soft and gentle.

If I have to describe the new WaveOne Gold Files from Dentsply-Sirona I would say that " it feels like canals are shaping the file and not the file that is shaping the canals."

With the new 3D Endo Software I can plan my cases more accurately, do a cost calculation and print a report for the patient which helps the patient to understand the treatment planning better.

The WaveOne Gold Files and 3D Endo Software could be an excellent example to be expected in future as a merger between Dentsply and Sirona making the two giants combine their expertise in the dental world.

INTEGRATING 3D FACIAL SCANNER IN IMMEDIATE FULL MOUTH REHABILITATION PROCEDURE

Dr. Miguel Stanley, DDS

Dr. Miguel Stanley is a dental surgeon, TV host, executive producer, author, and international lecturer, based in Lisbon, Portugal. Born in Durban, South Africa to an English mother and Portuguese father, he graduated in dentistry in 1998 and went on to specialize in implant and cosmetic dentistry in 1999-2000, allowing him to focus, early on in his career, on advanced complex oral rehabilitation.

Dr. Miguel Stanley

As Founder and CEO, he practises daily at White Clinic, Lisbon, Portugal, where he leads a staff of over 30 including a team of 12 dedicated dental surgeons. In the past, the clinic was an interdisciplinary practise with cosmetic dentists, plastic surgeons, nutritionists, spa, dermatologists, and image consultants, but over time, Dr. Stanley has downsized his practise to focus on his true passion, dentistry. He is regularly invited to lecture, giving over 15 keynote lectures around the world each year, and has spoken in over 49 countries.

Introduction

In recent years, immediate oral rehabilitation procedures for edentulous jaws using osseointegrated dental implants have been a commonly discussed topic among clinicians. [1, 2]. This type of treatment is challenging due to the multiple surgical and prosthetic steps required in order to achieve a good aesthetic and functional outcome. As a consequence, oral rehabilitation treatments often face several challenges: lack of clinical time, increased patient visits [3], patient discomfort, and high treatment costs [4].

The immediate complete prosthesis provides significant advantages: it avoids psychological and social problems for the patient because they do not experience an extended period of edentulism. Furthermore, the immediate complete prosthesis acts as a surgical stent, controls bleeding, promotes healing and protects the surgical site. It also helps to maintain the vertical dimension of occlusion, lower facial height and provides soft tissue such as lip and cheek support in order to keep proper muscle tone and tongue position [3].

It is necessary to point out that maxillary rehabilitation faces certain challenges. Not only does it need to satisfy the patient's functional requirements but also their aesthetic expectations. The availability of comprehensive information regarding the dental, skeletal, and soft tissue facial profile can help lead to a successful outcome [5]. Conventional methods for facial appearance analysis are based on limited two-dimensional (2D) measurement methods, such as capturing series of 2D photographs from different angles [6]. They fail to show the patient in 3 dimensions (3D) or show a soft tissue profile - an essential requirement for the upper jaw in order to achieve suitable aesthetics [7]. 3D facial scanning provides a virtual replica of the patient which can be used for comprehensive diagnostics and for planning suitable treatment procedures. This information can be used for digital evaluation when changing the position of teeth, their forms and colors and facial appearance; to fabricate virtual mockups or provisional prosthesis [5].

The purpose of this study was to evaluate an immediate function protocol by using a 3D facial scanner for fixed complete-arch prosthesis in the completely edentulous maxilla supported by seven implants.

Cash Report

In November 2016, a 64 year old woman came for a

rehabilitation treatment at White Clinic complaining primarily of the unpleasant aesthetic of her smile and of masticatory problems. After a clinical examination and x-ray analysis, a treatment plan was proposed, based on the No half smiles® concept. The purpose of the No half smiles® concept is rehabilitating the whole smile biologically, functionally and aesthetically. It also has an emotional component since the aim is to give the patient a better quality of life. The treatment plan included a surgical element and a restorative element and was divided into a temporary phase and definitive phase.

Extraoral and intraoral (frontal, lateral and 45°) photos were taken with a digital, single lens, reflex (DSLR) camera, as well as a facial scan (Face Hunter, Zirkonzahn®) to help with the treatment planning and diagnosis.

Fig. 1 Initial situation

The surgical procedure in the lower jaw began with the four inferior incisors (#31, #32, #41, #42) and the 2nd inferior molar extraction (#47), due to their severe mobility (grade III), and an immediate implant placement was made in the location correspondent to the #32 (3.5ØxL13mm)

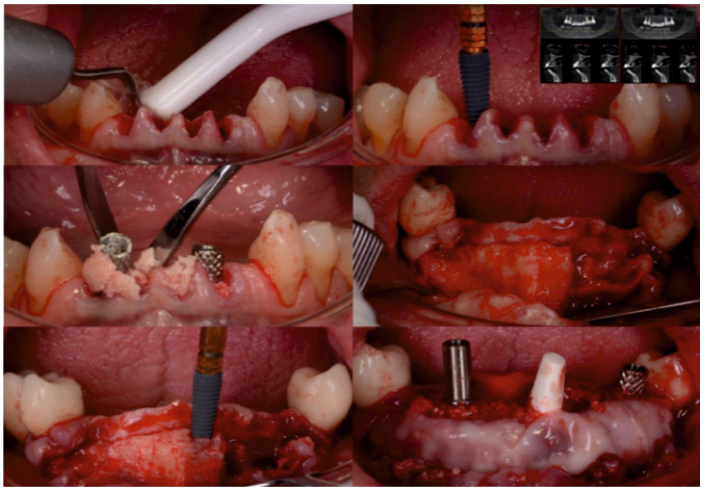

Fig. 2 Surgical Procedure

Fig. 3 a) After surgery and b) 1 week follow up c) 2 weeks follow-up

Fig. 4 Facial Scanner Sequence

T=50 Anyridge Megagen®, Korea), #42 (3.5ØxL13mm T=50 Anyridge Megagen®, Korea), #36 (4ØxL8.5mm T=50 Anyridge Megagen®, Korea), #46 (4ØxL8.5mm T=50 Anyridge Megagen®, Korea). The alveolus were prepared with ultrasonic instruments (Piezomed®) and after the immediate placement of implants, bone regeneration was carried out using xenograft (Gen-Os, Osteobiol ®, Italy). Two temporary metal abutments (Megagen ®, Korea) were placed in the implants placed in the position of teeth #32 and #42.

In the upper jaw, a flap was opened to place implants, and bone modulation was carried out using ultrasonic instruments (Piezomed®). Implants were placed in the location correspondent to teeth #13 (4ØxL10mm T=50 Anyridge Megagen®, Korea), #11 (3.5ØxL15mm T=50 Anyridge Megagen®, Korea) and #22 (3.5ØxL15mm T=50 Anyridge Megagen®, Korea). Bone regeneration was carried out with xenograft (Gen-Os, Osteobiol®, Italy) mixed with i-PRF and a-PRF membranes. Three different temporary abutments were placed: a multi-unit abutment temporary cylinder (#22), a fuse abutment (#11) and a temporary metal abutment (#13) (Megagen ®, Korea). The flap was closed with a 5-0 suture (Hu-Friedy ®), without tension and applying the suture technique described by Prof. Joseph Choukroun: the deep apical mattress.

Immediate provisional crowns were made with bisacryl A2 (Structur 3, VOCO®, Germany) from an initial alginate impression. The provisional structures were screwed to the provisional abutments.

After surgery the ATP38 laser (Swiss Bio Inov ®) was applied during 8min, based on the low level laser therapy, which accelerates the healing process.

A hyaluronic acid oral gel 0,2% (Gengigel®, Ricerfarma) and a hyaluronic acid mouthwash 0,1% (Gengigel First Aid®, Ricerfarma) was prescribed for use during the week following surgery to help the healing process.

One month after implant placement, final impressions were taken with polyether impression material (Impregum Penta, 3M) to produce provisional PMMA structures.

One week later, a superior provisional prosthesis fabricated in PMMA screw-retained on Anyridge Megagen® implants on the upper jaw was placed.

In March 2017, inferior teeth preparations were made in teeth #45, #44, #43, #34 and #35.

Final impressions (Impregum Penta, 3M), intraoral photos and the facial scan (FaceHunter, Zirkonzhan®) were taken. All this information was sent to the lab.

Final prosthesis was planned thanks to Zirkonzhan Modellier software, that works with the information that was registered by the facial scanner (FaceHunter, Zirkonzhan®).

In April 2017, a passivity test was carried out and the try-in of the upper arch was tested.

That month, tooth #35 was diagnosed with an irreversible pulpitis, and a root canal was successfully performed. The process was made with rubber dam and the root canals were prepared with the Protaper Gold (Dentsplay®) file system. The irrigation protocol was NaCl (5,25%) during the root canal preparation, and citric acid (10%) and NaCl (5,25%) for the optimization of the irrigation. The canals were obturated with the continuous wave of obturation technique (B&L, Biotech®)

Stratified Emax crowns (Ivoclar Vivadent®) were placed on the location of teeth #46 #45, #44, #43, #33, #34, #35 and #36 and a zirconia structure (Zirkonzhan®) with stratified Emax ceramic (Ivoclar Vivadent®) in #32, #31, #41, #42. These were cemented with resin-modified glass ionomer dental cement (Relyx Ô, 3M).

In May 2017, the definitive superior hybrid zirconia ceramic (Zirkonzhan®) with stratified Emax ceramic (Ivoclar Vivadent®) prosthesis was placed and screwed to the superior implants.

Discussion

Although virtual diagnostic technology and treatment planning workflows have been evolving, the creation of a 3D virtual patient still remains complex. To create a 3D virtual patient, 3D

diagnostic data must be integrated into a single entity [5; 8-10].

Facial scanners have been recently introduced into the dental workflow as diagnostic and marketing tools, as they permit the clinician to explain the patient's problem, and with help of digital software, show a preview of the final result [11].

Face Hunter (Zirkonzhan) is the facial scanner that was used in this case report for the 3D digitalization of the patient's face. In combination with the intraoral scanner, the Face Hunter allows us to connect the digital intraoral image with the facial scan data, using a virtual articulator, which can also allow us to control the facial arc virtually, and achieve more precise results. Furthermore, in combination with CAD/CAM software, it is possible to achieve an even more accurate preview of the final result.

Thanks to these types of technologies, it's possible to create a restauration based on the patient's face, as well as being able to show the patient what the final result will look like.

Conclusion

In conclusion, in this particular case, the facial scanner helped to produce a very accurate diagnosis and to achieve a more precise final rehabilitation.

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ONE ON ONE SESSION WITH Dr. Michael D. Scherer

Dr. Michael D. Scherer, DMD, MS, FACP


Dr. Michael D. Scherer

Dr. Michael Scherer is an Assistant Clinical Professor at Loma Linda University, a Clinical Instructor at University of Nevada - Las Vegas, and maintains a practice limited to prosthodontics and implant dentistry in Sonora, California. He is a fellow of the American College of Prosthodontists, has published articles, DVD training series, and in-person and online courses related to implant dentistry, clinical prosthodontics, and digital technology with a special emphasis on implant overdentures. As an avid technology & computer hobbyist, Dr. Scherer's involvement in digital implant dentistry has led him to develop and utilize new technology with CAD/CAM surgical systems, implement interactive CBCT implant planning, and outside of the box radiographic imaging concepts. Dr. Scherer also maintains two online courses:

1- Fast - Track Digital Dentistry & 3D Printing.

2 - Fast - Track Full - Arch Reconstruction Implant Overdentures, and five YouTube channels:

"Learn LOCATOR", "Learn LODI", "Learn SATURNO", "Learn LOCATOR F-Tx" and "The 3D Dentist"- popular YouTube channels on dental implant procedures and digital dentistry.

1. Can you share about your educational qualifications?

I am a board-certified prosthodontist, a type of dentist that manages and works with patients that are significantly medically compromised, missing many teeth, and are in need of major reconstruction of their teeth and jaws. I currently hold two academic positions, one at University of Nevada Las Vegas, and the second at Loma Linda University. I have had extensive background working with computers and with digital methods to assist in interpreting cone-beam CT radiography, progressive applications and education. In fact, I have personally educated thousands of students on working with 3D imaging and CBCT planning!

2. What do your Advanced In Person Fast-Track Digital Dentistry courses, provide to the participants?

I have been teaching techniques related to digital dentistry including intraoral scanning, CBCT planning, surgical guides, and in-office desktop level 3D printing. In fact, I developed the first course in the world on combining these techniques! We debuted this course several years ago in San Francisco and have been running in-person courses focusing on these techniques ever since. We have priced our courses very reasonably and far below the average cost of what most clinicians would typically pay to attend these courses. The courses have been so popular that many have replicated this concept throughout the world!

As a result of the popularity, doctors have requested advanced courses on full-arch and complex workflows and closer to their homes so they would not have to travel to California. As a result, I have developed a fully online web - browser based course (www.LearnDental3D.com) with approximately 20 hours of video-based education with a step-by-step protocol for working with optical

scanning, open platform software, and desktop 3D printing. The course has been hugely popular and the feedback has been tremendous with multiple people requesting integration of many of the workflows into academic environments.

3. How do you see 3D printing shaping the dental industry?

I feel 3D printing is one of the most significant technological innovations in clinical and laboratory dental practice in sometime! After incorporating optical scanning into my clinical practice, I had a need for fabricating physical models from the optical scans I was creating on my patients. I was exposed to multiple companies providing industrial-grade 3D printing solutions and printers costing between $20-150,000 and thought to myself, "Could I use lower cost, desktop-grade printers and do a similar workflow as these larger machines?" As a result, several years ago I invested in multiple 3D printers including many on kickstarter campaigns that cost between $2,000-5,000. After some frustrating experiences with machines that were designed for engineers, I found Formlabs printers were very promising for dentistry as they were very simple to use and plug and play.

While dentists typically are relatively slow to adopting technology, desktop-level 3D printing is different. There is a need for clinicians to be able to utilize their existing technology in creative methods and leveraging them to enhance their patients' experiences at the office. Case in point, one of the first patients I treated with a 3D printing workflow came to me because she heard that I could make "impressions without the gooey material!" Over the course of 10 years, she saw 5 different dentists who all remarked that she was going to lose her front teeth. She was given the options for tooth replacement but never took the next step. Fear of surgery? Gagging reflex? Neither, the patient was terrified at the *thought of an impression removing her teeth* and never started treatment because of it. Fast forward, she presented to my office when she heard I did digital impressions *and* 3D printing and could skip a traditional impression to do her treatment. She accepted and was thrilled with the results!

4. What have been some challenges or road barriers you have experienced in utilizing digital technology?

The 3 major barriers most dentists face for implementing digital technology are: 1) cost, 2) indifference, and 3) fear. Without a doubt, digital technology is expensive to implement and any technology is going to be more expensive, *at least initially*, compared to traditional analog methods. The good news? Dental technology is rapidly becoming more affordable desktop level 3D printing has been a huge portion of this drive. In fact, in the past few years, 3D printer costs have gone down from a high of around $30-120,000 compared to where we are now, between $3,500-15,000! Technology companies, like Formlabs, have created printers that can produce quality prints at a fraction of the cost compared to more expensive machines.

Dentists are creatures of habit, for many good reasons. We, as consumers & patients, value experience in a doctor. We understand that expertise is an important factor in potential success of a medical procedure. In response to this desire, dental clinicians feel the need to produce a similar product/outcome every time and ultimately they fall into a technical rhythm. New technology or new techniques can potentially disrupt this rhythm. A significant challenge that technology companies have to manage is working with clinicians to encourage them to step outside of their comfort level and try something new.

As a result of the aforementioned, some

clinicians tend to be *fearful* of technology. Now not the scary movie sort of fear but the *fear of the unknown*. Will this technology work for me? I know Dr. Scherer can do it, but can *I do it?*

5. What do you suggest other dentists do when deciding which products and software to implement into their practice?

This question comes up quite often. The big question to answer is, "Do you want a simple, fully integrated, albeit a more expensive, solution that is simple plug and play or do you want an open system that, while is free, is more complicated at first to learn?" I have been working with both systems in my practice and there is a time and place for both. Many clinicians are concerned with software choices, and rightfully so! While there are a few main choices in dental software, they are expensive and often meant for laboratories, not clinicians. I have been teaching workflows for clinicians to use in their offices using free/open source CAD engineering software. Things that anyone can pick-up right away and experiment with. Once a clinician is comfortable with these workflows, they can "graduate" to more advanced dental system workflows.

6. How has 3D printing advanced your practice and personal goals?

3D printing has been one of the most amazing things I have incorporated into my clinical practice in years! I use it for being able to generate dental models, surgical guides, diagnostic assessment tools, nightguards, and even crazy things. One of the biggest reasons I use 3D printing in my practice is for marketing. For example, a key part of my practice is marketing to patients that I run a *modern dental practice*. I now have tremendous fun with marketing 3D printing technology, including giving away phone charger holders with my practice emblem on them and also practice mascot toys… all generated with my 3D printer.

Naturally, I have found the biggest improvement with in-office 3D printing is improving patient care. Now, my routine is digital dentistry, minimal impression gooey material, and improved precision of my clinical results. Less trips for my patients to our practice means happier patients and more productive time spent treating patients, instead of costly revision treatment. Finally, I can leverage 3D printing to be able to do things that would normally take weeks in a laboratory, I can produce in just a few hours for minimal cost. Amazing.

7. What are your future plans with respect to 3D printing, CAD/CAM, and MRI?

It has been a fun journey so far! I look forward to working together with 3D printing companies, universities, and to develop new technology and workflows. I have always found it rewarding with educating and bringing complex technological techniques to everyday clinicians in dental practice. I envision an environment where we can all come together in a collaborative environment and learn from each other. We have gotten closer with the dynamic nature of forums, groups, and online connections, however, we need to do much better. We need to challenge ourselves to continued progress, we need to interact and work together, and we must always keep our patients in the center of our goals to ultimately strive to improve patient care and dental treatment.

8. How do you see CBCT and CAD/CAM technology advancing in your area of profession?

Near time, I anticipate the proliferation of CBCT and CAD/CAM into many early adopter practices. As with any technology, adoption rates follow a bell-shaped curve of

implementation, I do think 3D printing is promising because it's just so practical. Ultimately, I do believe every dentist in the world should be using scanning and printing techniques to enhance patient care.

9. What types of changes are you looking forward to in the future?

I do believe we are just at the beginning of implementation of 3D printing in dental practice. Intraoral scanning and 3D printing has been around for almost 30 years yet less than 15% of dental practices have implemented the technology, why? Traditionally the reason for lack of implementation has been complexity, cost, and fear. As the prices become more affordable, the workflows become more established, and in-person and online education becomes more utilized, dentists will embrace digital techniques almost the same way as they utilize traditional analog techniques. Intraoral scanning, 3D printing, and CBCT radiography helps to solve clinical problems. I am looking forward to seeing where dentistry goes!

10. What types of support/customer service from the distribution companies or manufacturers, would benefit you and other dentists when implementing a digital workflow into their practice?

One of the biggest challenges we are working with is the limited development of materials for 3D printing. We are eagerly looking forward to new materials to be able to be printed, including dentures, tooth-colored materials, and ceramics. Additionally, we must get companies to push forward biologically compatible and long-lasting materials that we can utilize directly in the mouth as final restorations instead of just prototypes for our patients. Until then, we will be limited with our technology and will still need to rely upon traditional methodology to finalize the final product. I would encourage dental technology companies to work hard at making technology more attainable for everyday clinicians financially and done so in a way that is simple to utilize. We are in a new world of business and technology, however, the traditional relationships of how we work together with manufacturers and technology experts remains strong.

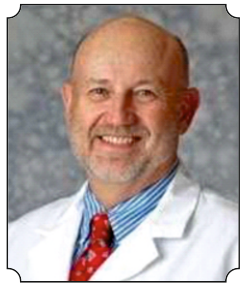
11. What do you do in your leisure time?

I am hopelessly and tirelessly addicted to technology. Digital technology is fun for me and I can't get enough! I do have a life outside of technology, I enjoy fishing, scuba diving, and skiing with my wonderful wife, but even while I'm out skiing, I run into CBCT scanning and 3D printing applications, like one time I met a patient of mine on the ski hill near home and he was complaining about his ski boot bottom heel. He mentioned it was worn out and needed a replacement, the quote, $500. I told him to bring it in to my office and I'll see what I can do. He brought his ski boot in and I was able to CBCT scan the part of the boot that was broken, digitally designed a replacement, and 3D printed a replacement in my dental office. We then did 2 arches of full-arch immediate load implant bridgework using open-source software to aide in the design process. Amazing!

I love interacting with dental students and residents. I find that the new generation of dentists has now grown up with video games, technology, and interactive tablets. Using CBCT software comes easily to them, 3D printing is not strange, and thinking is unencumbered with traditional thought. Many began their digital dentistry journeys with video games, priming them with understanding how a computer works. Playtime is now professional time, and vice versa. As Steve Jobs once said, “Stay hungry, stay foolish” and we will be forever challenged to strive forward in our professional lives.

8 CONE BEAM CT CASE REPORTS

Dr. Paul A. Jones, DDS, MS



Dr. Paul A. Jones

Paul A. Jones, DDS, MS attended the University of Kansas School of Pharmacy, received his DDS from UMKC, practiced general dentistry in Lawrence Kansas for two years, received a Master's in Endodontics from the University of Nebraska, Lincoln, and was in private practice limited to Endodontics in the Kansas City area for over thirty-five years. He has utilized personal computers for over thirty years, digital radiography for over twenty years, and Cone Beam CT for over eight years. He is a member of the American Dental Association, the American Association of Endodontists, the American Academy of Oral and Maxillofacial Radiologists, Omicron Kappa Upsilon, and Phi Kappa Phi. His other passions are sailing and digital photography.

Introduction:

Two-dimensional periapical radiography is used routinely in endodontics. Cone Beam CT is a powerful tool to aid in the diagnosis and treatment planning of endodontic cases where more information is needed. (1) This article reports seven cases where using Cone Beam to view teeth and bone in all three dimensions changed the diagnosis and treatment plan.

Materials and Methods: All Cone Beam CT scans were taken with a Kodak-Carestream 9000.

Case Reports :

Patel & Dawood (2) concluded that Cone Beam CT's (CBCT) superior diagnostic accuracy resulted in an increased likelihood of correct management of resorption lesions compared to periapical radiographs (PA). Patel (3) says that External Cervical Resorption (ERC) can be difficult to diagnose and manage and CBCT is a good tool to diagnose, evaluate the true extent, and manage ERC. Algerban (4) states that high quality CBCT images are important in detecting root resorption and found no significant differences between 6 different CBCT machines. Estrela (5) and Kamburoglu (6) concluded that CBCT is better than periapical radiography in detecting inflammatory root resorption.

Vaz de Souza (7) showed that Kodak (now Carestream) and Morita CBCTs were equally effective at diagnosing and classifying External Cervical Resorption (ERC) and the Periapical X-rays were significantly less effective.

Case # 1

(Figure 1) The PA shows some ERC but CBCT shows the actual much larger size and more accurate location of the ERC. Using just the PA, one might be misled as to the actual size and location of the defect. Information from the CBCT would affect the treatment plan in this case.

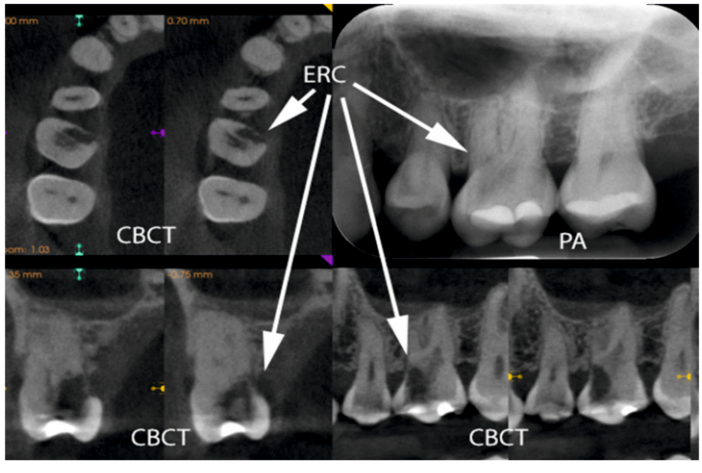


Figure 1

Case # 2

The upper left first molar was symptomatic. The PA (Figure 2) showed a slight hint of internal resorption. The CBCT (Figure 3) showed a dramatically larger internal defect. Viewing a CBCT would affect the treatment plan of this case.

Figure 2

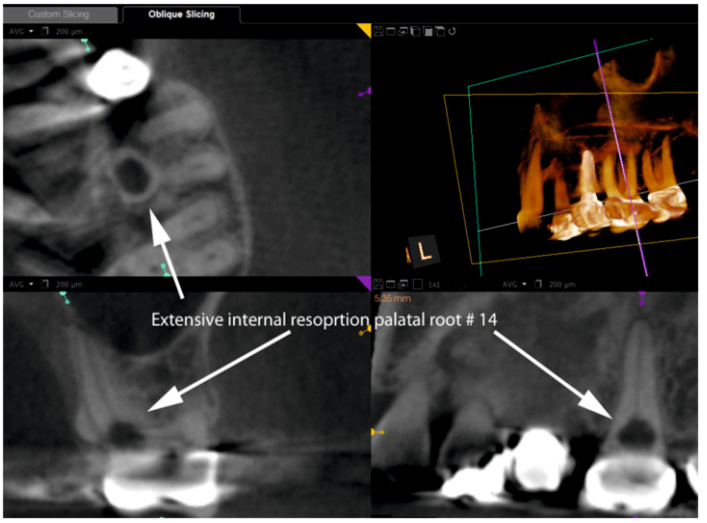


Figure 3

Case # 3:

The lower right first remained symptomatic after non-surgical root canal treatment by a general dentist. PA (Figure 4) did not reveal the cause of the problem. CBCT (Figure 5) showed two untreated root canals, one in each root. CBCT revealed the location of the missed canals.

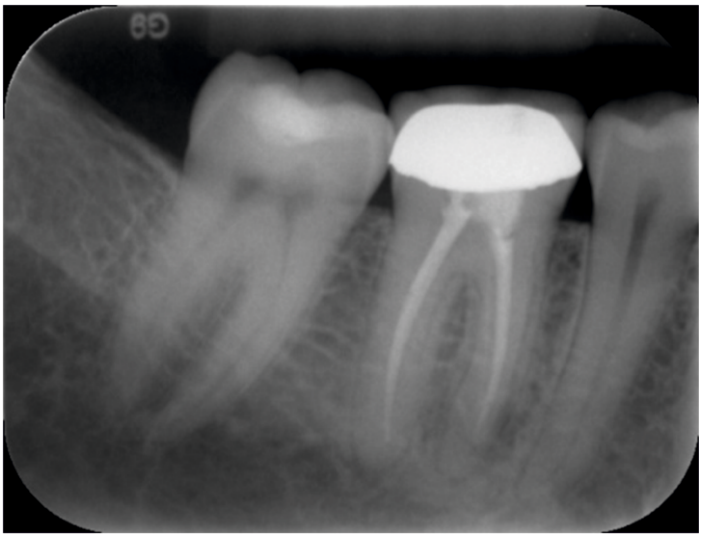


Figure 4

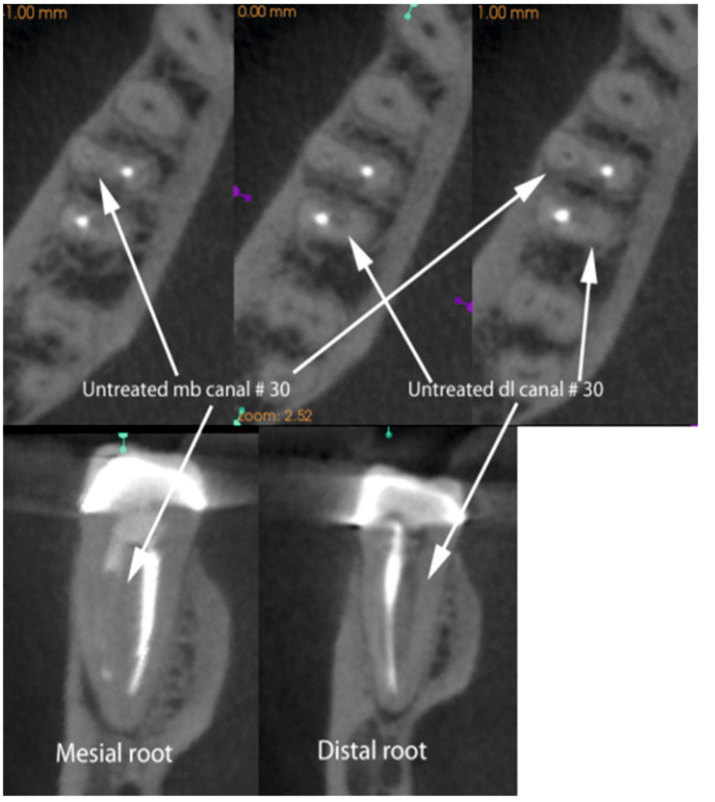


Figure 5

Case # 4:

The lower right second bicuspid was symptomatic and had a sinus tract on the buccal. PA (Figure 6) showed a lesion at the apex. CBCT (Figure 7) shows a post perforation on the buccal. Information gleaned from taking a CBCT changed the treatment plan in this case.

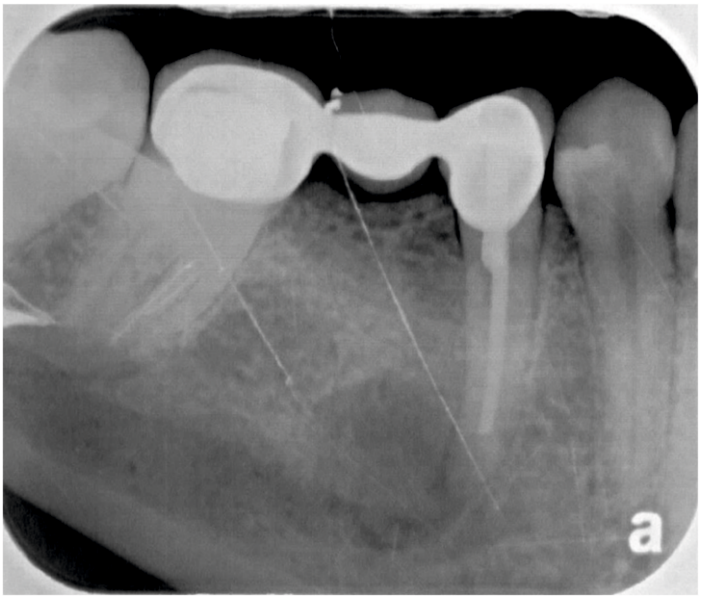


Figure 6

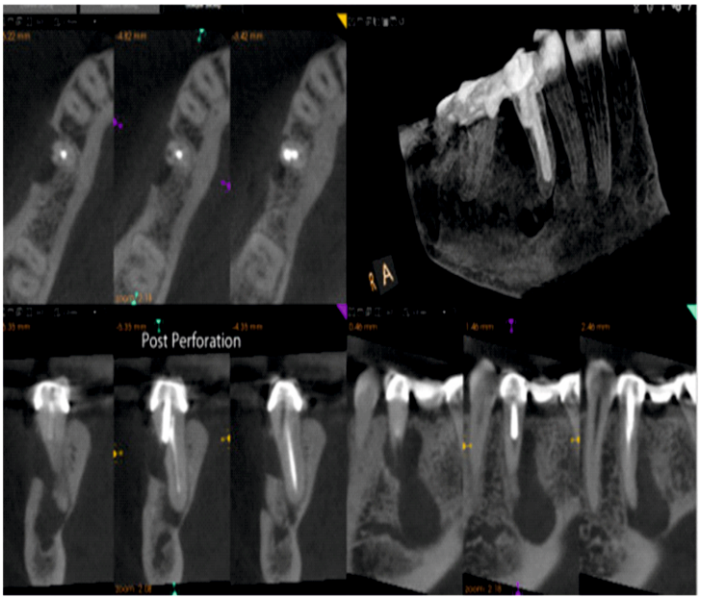


Figure 7

Case # 5:

Kajan and Taromsari(8) concluded that CBCT was good at detecting root fractures.The upper left first molar was symptomatic. PA (Figure 8) shows the root canal filling short of the apex and separated instrument in the mesial buccal root. CBCT (Figure 9) shows a vertical root fracture of the palatal root. Addressing the shortcomings of the treatment of the mesial buccal root would not solve the true problem and expose the patient to unnecessary and expensive treatment.

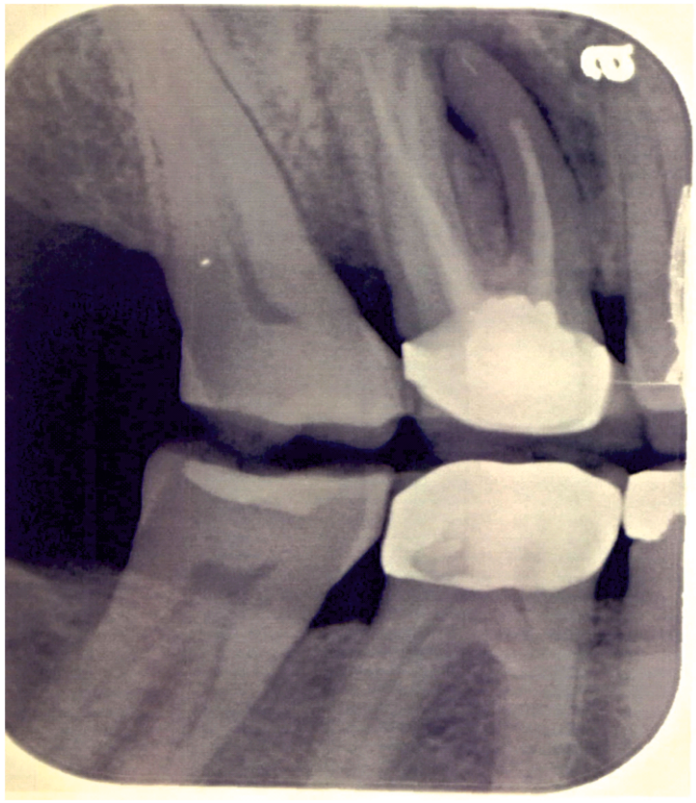


Figure # 8

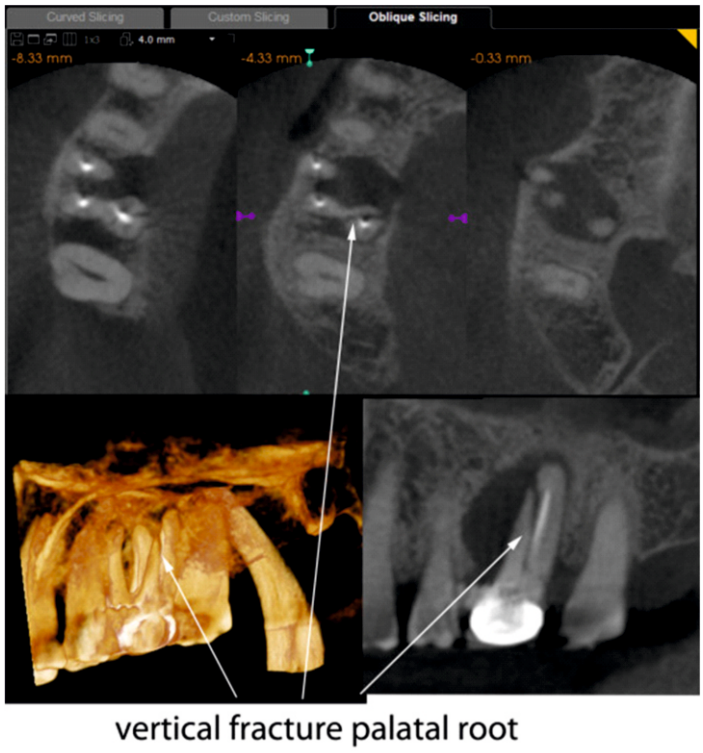


Figure # 9

Case # 6.

This patient fell and completely avulsed her lower right central and lateral incisors. They were re-

implanted in the emergency department of a local hospital. Her dentist splinted them. Two weeks later she came in for root canal treatment. PA (Figure 10) was unremarkable but CBCT (Figure 11) showed the facial bone was missing and the roots were not re-implanted in the sockets.Without the diagnostic information revealed by the CBCT root canal treatments most likely would not have healed.

Figure 10 PA of avulsed lower incisors

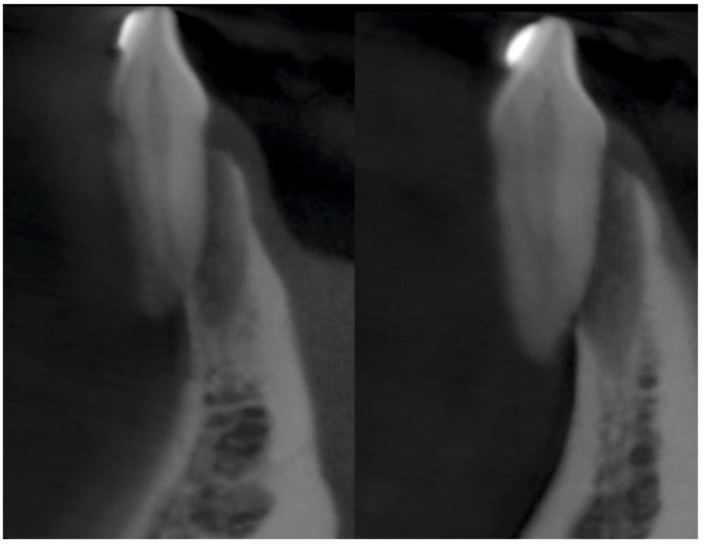


Figure 11

CBCT shows teeth were not implanted in socket

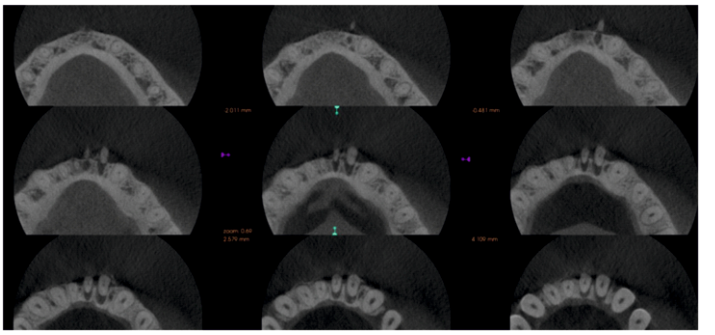


Figure 12 Axial view

Case # 7:

Wanderley(9) discusses CBCT beam hardening from root canal fillings that create artifacts masquerading as cracks. The arrows in Figure 13 point to such artifacts. One must be careful in teeth with root canal fillings and metal posts not to over diagnose cracks.

Figure 13

Case # 8:

Figure 14 shows a sinus tract above the left central incisor mid root. Both centrals reacted slightly to cold. The PA (Figure 15) was inconclusive.

Figure 14

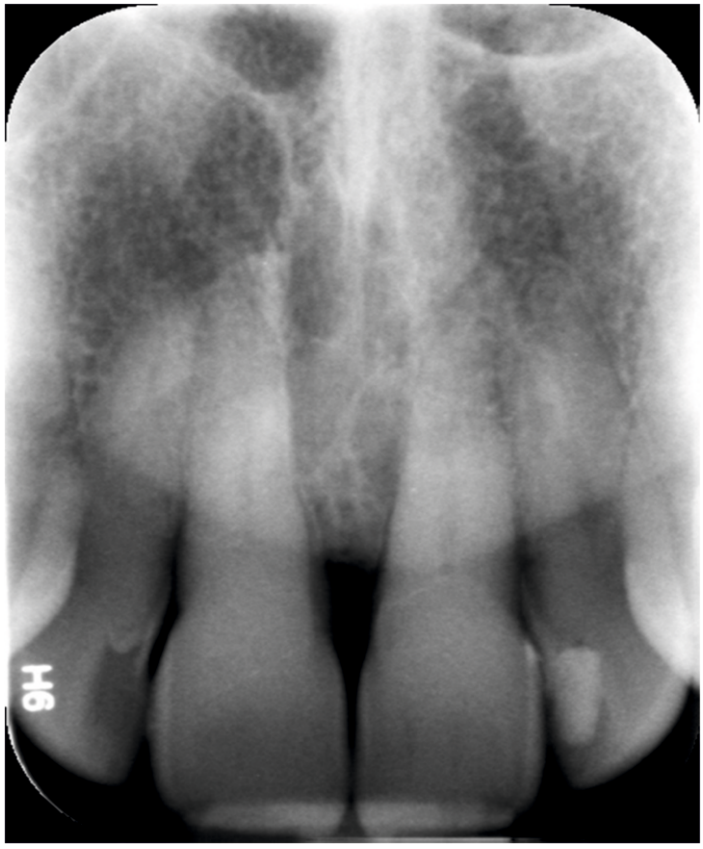


Figure 15

CBCT (figure 16) showed lesion along the sides of the roots of both central incisors.

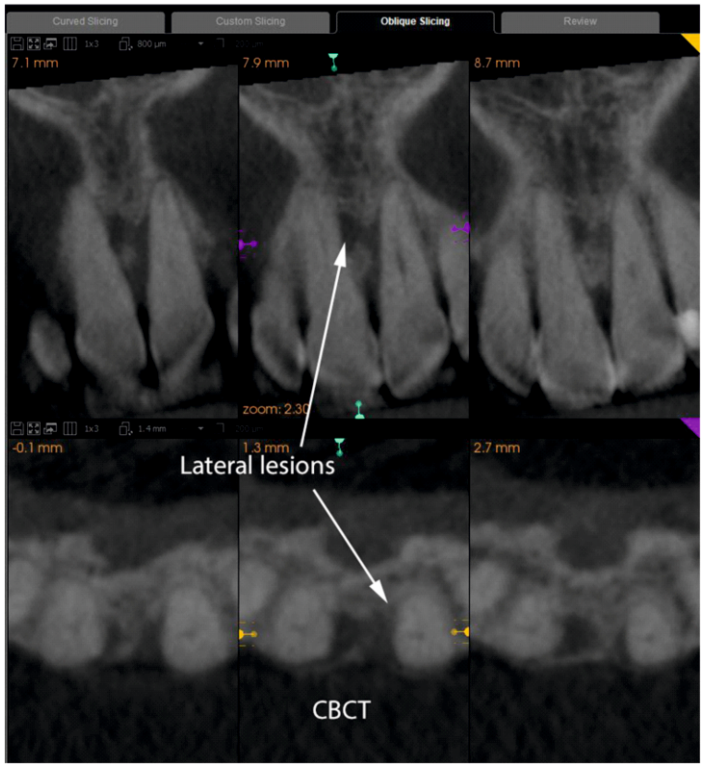


Figure 16

CBCT showed bone around the apexes of both teeth. (Figure 17)

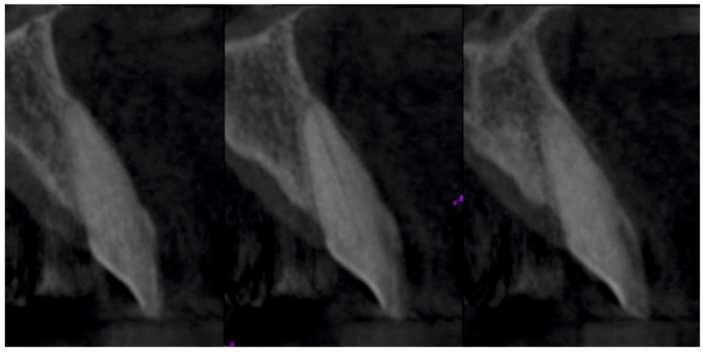


Figure 17

A flap was raised, the lesion was curetted, the roots were scaled, and pieces of necrotic cementum were removed. (Figure 18)

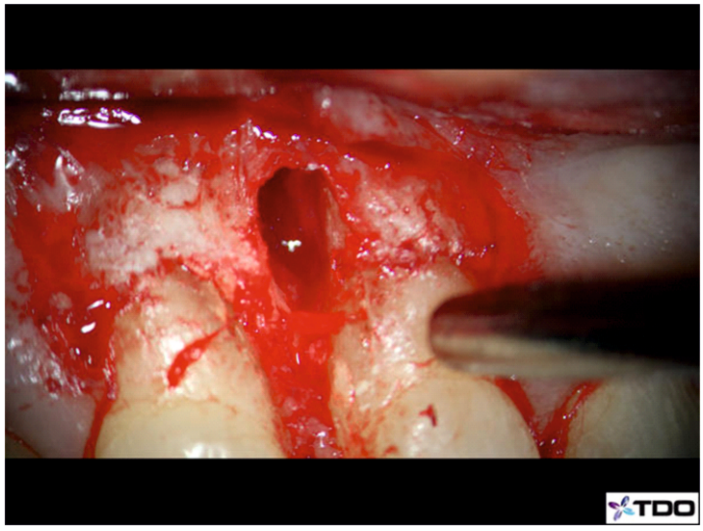


Figure 18

A cystic lesion was submitted for microscopic examination and was reported as an apical periodontal cyst. Figure

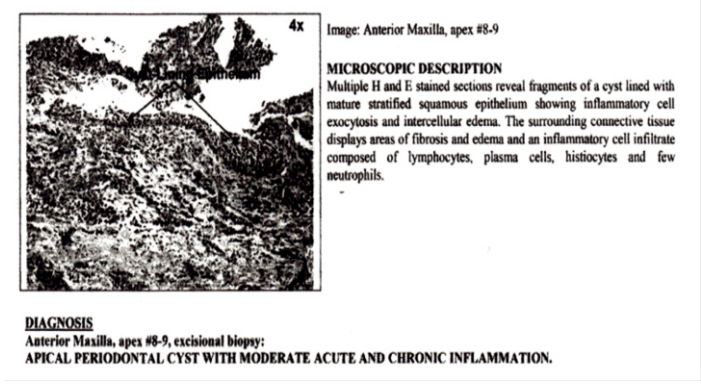


Figure 19

The sinus tract healed, the teeth remained asymptomatic and still slightly reactive to cold. One year later the lesions had decreased in size (Figures 20& 21).

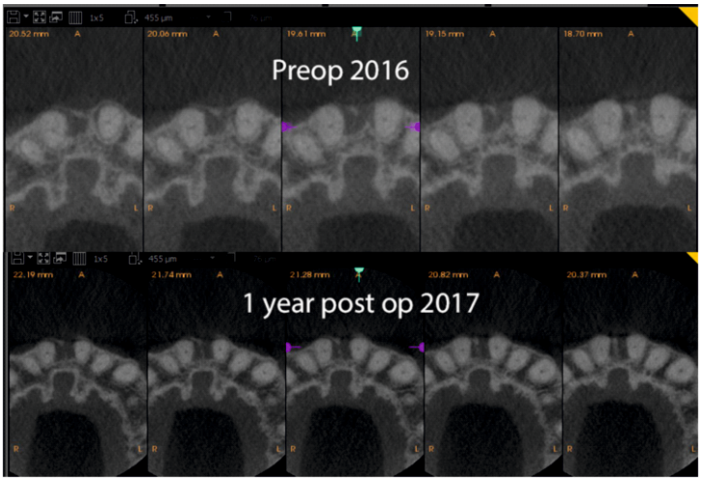


Figure 20

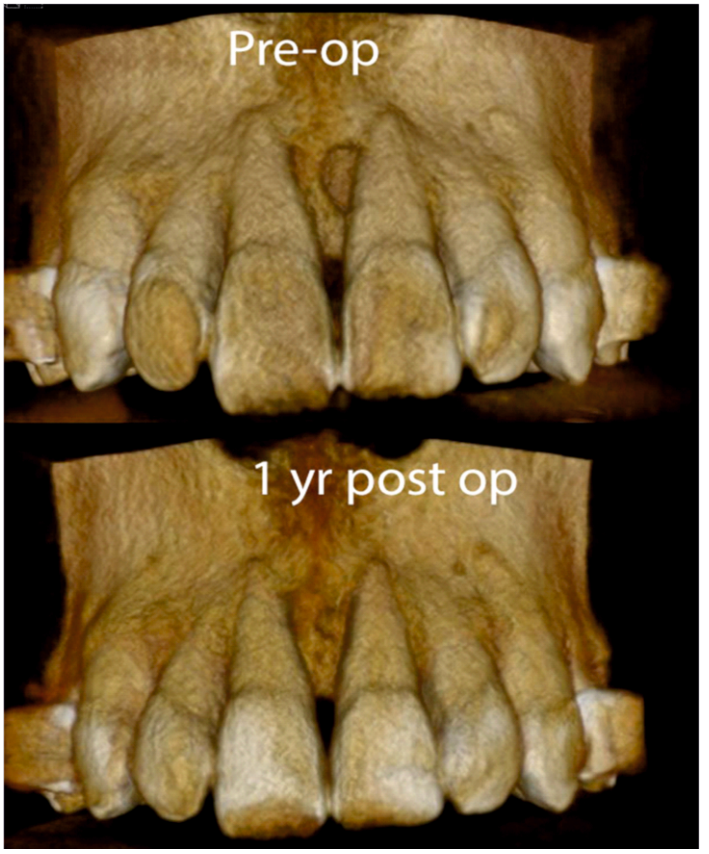


Figure 21

Summary:

Viewing teeth and bone in all three dimensions with Cone Beam CT can often better reveal the cause of a dental problem than viewing them with two dimensional periapical x-rays alone leading to a more accurate diagnosis and appropriate treatment plan. This article shows 8 cases where CBCT led to a different diagnosis and treatment plan than one made from just a PA. It also shows a case where CBCT artifacts could be misinterpreted as cracks in the roots.

Conclusions: In some cases Cone Beam CT can display conditons not readily seen on Periapical X-rays. One must be aware that artifacts on CBCT scans caused by root canal fillings can be misinterpreted as cracks in the root.

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GUBERNACULAR CANAL : AN INCIDENTAL FINDING ON CBCT

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ABSTRACT: Gubernacular cord is the structure coming from the dental lamina located within the alveolar bone scaffold, so called gubernacular canal. Aim of this case report is to describe the radiographic appearance of gubernacular canal and to assess the location and anatomical course of the same on Cone beam computed tomography which could be missed as any aberrant nutrient canal present in the alveolus as it plays a pivotal role in pathogenesis of Adenomatoid odontogenic tumor.

INTRODUCTION:

Gubernacular dentis is a cord of connective tissue from a developing tooth bud to the developing tooth bud to the overlying mucosa. The first reference of gubernacular cord was given by English scientist John Hunter in 1778 who described this structure after observing a connection between the bony ridge of tooth in developmental phase and the gingiva (1). The role gubernacular cord in the process of eruption was first studied by Cahill and Marks who postulated that tooth follicle plays a fundamental role in the physiologic movement of the tooth towards the oral cavity and that if the gubernacular cord has some role in the process of tooth eruption (2).

CASE REPORT:

A 12 yr old female patient reported to the Department of oral medicine and radiology with a chief complaint of multiple missing teeth in the jaws. The patient was in good health and systems review was unremarkable. Extaoral examination revealed no significant findings; while intraoral examination revealed presence of over retained deciduous teeth in mandibular anterior region with missing mandibular and maxillary first molars. Conventional radiographs revealed unerupted multiple teeth in the jaws.

Cone beam computed tomography(CBCT) performed, is a three dimensional imaging technique, that has been specially designed for imaging the dentomaxillo-facial structures. The exam was performed with Kodak CS 9300 3D system, Carestream; the Frankfort Horizontal Plane parallel to the Horizontal Plane and perpendicular to the Median Sagittal Plane, with slices in all the three orthogonal planes and multiplanar reconstruction with the following exposure factors: 90 kVp, 10 mA, time 12 seconds.

CBCT revealed multiple unerupted teeth with tooth follicles of some permanent teeth.

Reconstructed panoramic view revealed Tooth follicles of mandibular permanent canines, premolars and permanent first molars.

Incompletely formed permanent mandibular second and third molars surrounded by bony crypt in the mandibular alveolus.(refer figure no 1)

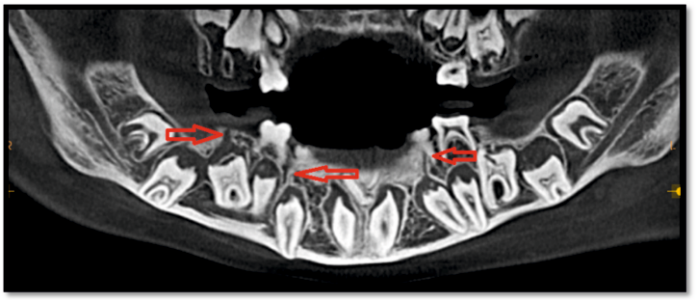

Figure 1 Panoramic Reconstructed View

Sagittal as well as coronal sections of the region of mandibular canines revealed a well defined corticated radiolucent tract in relation to the follicle of unerputed mandibular right and left canine extending from the centre of alveolus extending along the lingual cortical plate opening to the crest of alveolus.(Refer figure no 2,3&4).

Figure 2 Coronal Section

Figure 3 Sagittal Section of 33

Figure 4 Sagittal Section of 43

Sagittal as well as coronal sections of the region of mandibular second premolar of right and left side revealed a well defined corticated radiolucent tract in relation to the follicle of unerputed mandibular right and left second premolars extending from the centre of alveolus interdentally extending along the

lingual cortical plate opening to the crest of alveolus.(Refer figure no 5,6,&7).

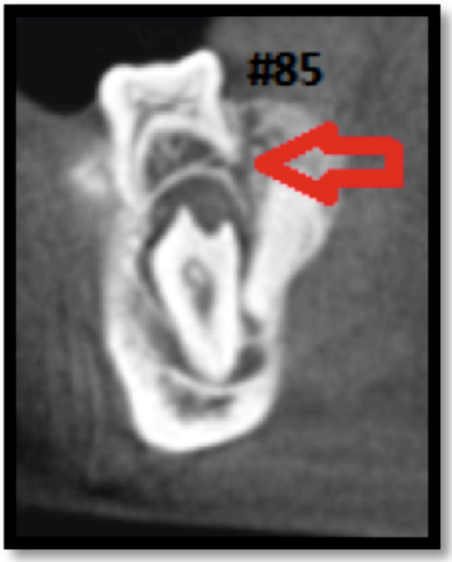

Figure 5 Sagittal Section of 85

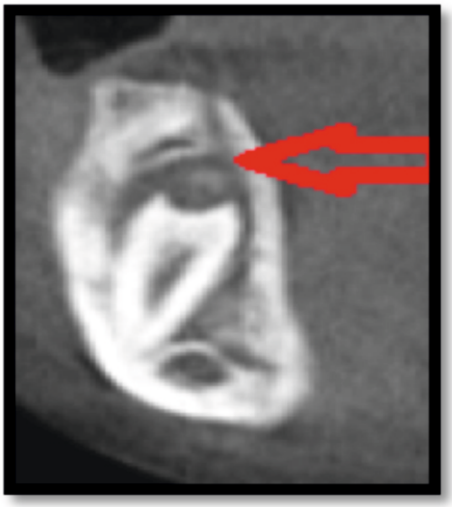

Figure 6 Coronal Sectino of 45

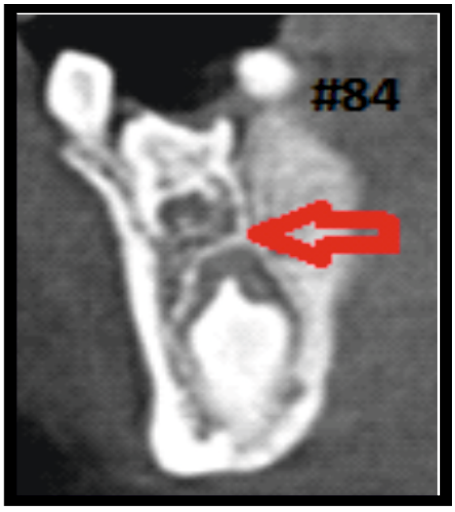

Figure 7 Sagittal Section of 84

Sagittal as well as coronal sections of the region of mandibular second first of right and left side revealed a well defined corticated radiolucent tract in relation to the follicle of unerputed mandibular right and left first premolars extending from the centre of alveolus interdentally extending along the lingual cortical plate opening to the crest of alveolus.(Refer figure no 8,9,10&11).

Figure 8 Sagittal Section of 75

Figure 9 Coronal Section of 75

Figure 10 Sagittal Section of 74

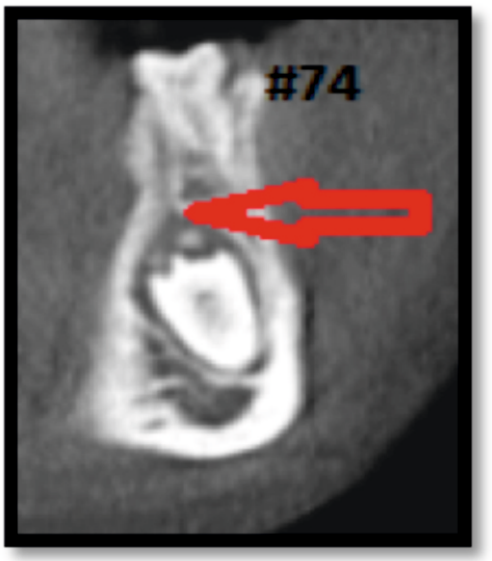

Figure 11 Coronal Section of 74

Figure 12 Coronal Section of 46

Coronal section of Mandibular right first molar revealed thick radiolucent corticated tract extending from the centre of alveolus above the coronal structure of unerupted molar to the alveolar crest.(Refer fig 12)

The CBCT sections revealed that there is a well defined radiolucent corticated tract associated with unerupted tooth which is suggestive of gubernacular canal and not any aberrant canal as it won't be present with every unerupted tooth.

On the basis of above mentioned findings the radiolucent canal associated with the tooth follicle of unerupted teeth was diagnosed as gubernacular canal.

DISCUSSION:

Gubernacular canal which connects the follicle of unerupted tooth to the overlying mucosa represents a radiolucent band in the same region. Tooth eruption is a physiologic process in which a tooth undergoing formation migrates from its developmental site within the alveolar process to its functional position inside the oral cavity. During this process, participation of different anatomic structures, cells, chemical and molecular mediators of which gubernacular canal is one important structure (3).

Significant histologic changes occur in the tissues overlying the erupting tooth; bone removal is necessary for the permanent tooth to erupt into the oral cavity. In case of deciduous predecessors, there is a canal which has an influence on the eruptive tooth movement that is the gubernacular canal which consists of gubernacular cord. When the permanent tooth germ first develops within the same crypt as its deciduous predecessor, bone surrounds both the tooth germs but does not completely close over them. As the deciduous tooth erupts, the permanent tooth germ becomes situated apically and is entirely enclosed by bone except for a small canal which often contains epithelial remnants of dental lamina. This canal is seen as

radiolucent canal extending from the centre of alveolus to the crest4.

During eruption, as the permanent tooth moves towards the axial direction to the oral cavity this canal widens by osteoclastic activity to accommodate the crown of erupting tooth.

There are different schools of thought associated with the presence of Gubernacular cord with deciduous and permanent dentition. According to Hudson, only permanent tooth with a deciduous predecessor is associated with gubernacular cord. While Scott elaborated that permanent molar that does not have deciduous predecessor also have their tooth germs connected to the oral mucosa by gubernacular cord- the so called molar gubernacular cord2.

Philipsen theorised that gubernacular cord could play a pivotal role in development of Adenomatoid odontogenic tumor because this contains the remnants of dental lamina and this relates to the pathogenesis of Adenomatoid odontogenic tumor4.

This anatomical structure might be missed out as they are not clearly visible on a conventional radiographs or mis interpreted as sinus tract or accessory canal or nutrient canals. But a sinus tract is usually located on the apical area of tooth and not the coronal portion and will take a path of least resistance and will be associated with carious tooth. In the similar way, a mandibular accessory canal could be traced back towards the mental foramen and is not associated with an impacted tooth; a nutrient canal running vertically are uniform in width & not associated with an impacted or unerupted tooth.

CBCT, thus emphasises the importance of the 3-Dimensional Imaging for dentomaxillofacial region as it enables visualization of bony architecture with high resolution and accuracy. The presence of accessory canals should be considered when performing pre-surgical planning for surgical procedures in the jaws, in light of the resulting potential risk of surgical complication. Additionally, the potential for the development of pathological processes associated with these accessory structures and their associated neurovascular bundles should be considered6.

CONCLUSION:

It is essential that the dental surgeons be aware of this additional anatomical structure which may remain unnoticed or mis- interpreted as a nutrient canal or an accessory canal in the alveolus as it serves as a potential risk factor for development of Adenomatoid odontogenic tumor. The diagnostic pitfalls of conventional radiography ought to be kept in mind and CBCT scan in such cases not only provides information regarding the position of impacted teeth but also emphasizes visualization of anatomical structure associated with it and helps in further treatment planning.

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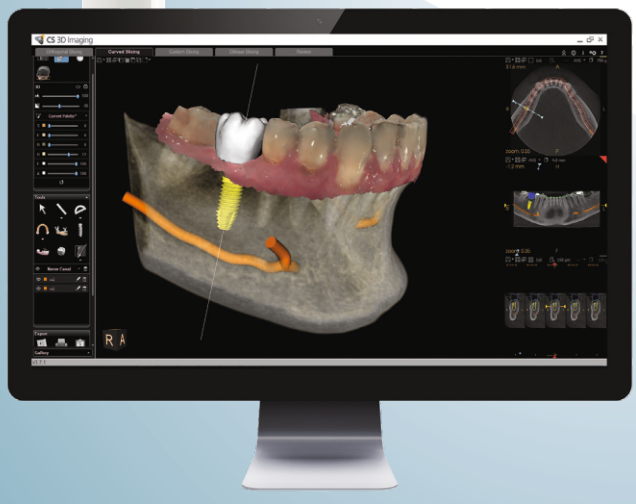

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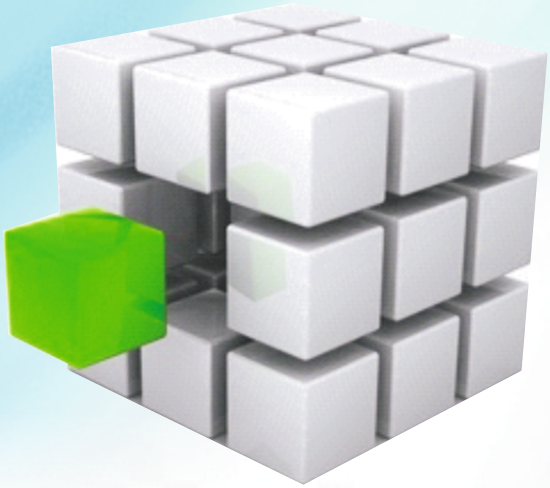

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